ARCHITECTVRE

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PLATES AND ILLUSTRATIONS

EDITORIAL

ASHER BENJAMIN ON ORNAMENT—WOMEN IN THE ARTS.

WE were shown at the office of a brother architect recently a series of old books by a country carpenter named Asher Benjamin, published about the beginning of the nineteenth century, which were used by the carpenters of that day in the design of the decorative parts of their houses. The plates were very interestingly drawn, as a rule well designed, and as there was accompanying each plate a brief description, we borrowed some of the books so that we might examine them at leisure.

Surprisingly enough the text was in many cases as interesting as the plates; full of sound good sense and practical advice, which, since art criticism, if it be valuable at all, is always valuable, we think it worth while to transcribe in part.

It will be learned from these remarks of Benjamin that the builders of Colonial days achieved their exquisite results, not by accident but by a very thorough understanding of the principles of their art, while certain of the shrewd observations made by this country carpenter in 1800 seem to touch the root of the use of ornament more closely than we have ever seen it touched by any professor or critic of our own time. We quote:

"As in many other arts, so in architecture, there are certain elementary forms, which, though simple in their nature, and few in number, are the principal constituent objects of every composition, however complicated or extensive they may be . . . . .

"The names of these are allusive to their forms; and their forms are adapted to the uses which they are intended to serve. The ovolo and ogee, being strong at their extremities, are fit for supports; the cimarecta and cavetto, though improper for that purpose, as they are weak in the extreme parts, and terminate in a point, are well contrived for coverings to shelter other members; the tendency of their out-

line being very opposite to the direction of falling water, which, for that reason, cannot glide along their surface, but must necessarily drop. The torns and astragal, shaped like ropes, are intended to bind and strengthen the parts on which they are employed; and the use of the fillet and scotia, is only to separate, contrast, and strengthen the effect of the other moldings; to give a graceful turn to the profile; and to prevent that confusion, which would be occasioned by joining several convex members together . . . .

"The most perfect profiles, are such as consist of few moldings, varied both in form and size; fitly applied, with regard to their uses, and so distributed, that the straight and curved ones, succeed each other alternately. In every profile, there should be a predominant member, to which all the others ought to seem subservient; and made, either to support, to fortify, or to shelter it from injuries of weather; and whenever the profile is considerable, or much complicated, the predominant should always be accompanied with one, or more, other principal members; in form and dimension, calculated to attract the eye; create momentary pauses; and assist the perception of the beholder. These predominant and principal members ought always to be of the essential class, and generally rectangular; Thus, in a cornice, the corona predominates; the modillions and dentils are principles in the composition; the cimarecta and cavetto, cover them; the ovolo and ogee, support them.

"When ornaments are employed to decorate a profile, some of the molding should always be left plain, in order to form a proper repose; for when all are enriched, the figure of the profile is lost in confusion. In an entablature, the corona should not be ornamented; nor the modillion band; neither should the plinths of columns, fillets, nor scarcely any square members be carved; for, generally speaking, they are either principle in the composition, or used as boundaries to other parts; in both of which cases, their figures should be simple, distinct, and unembarrassed. The dentil band should remain uncut, where the ovolo and ogee immediately above and below it are enriched; for when the dentils are marked, the three members are confounded together, and being covered with ornaments, become far too rich for the remainder of the composition, which are defects, at all times, studiously to be avoided; as a distinct outline, and an equal distribution of enrichments, must on every occasion, be strictly attended to.

"Ornaments should neither be too frugally employed, nor distributed with too much profusion; their value will increase, in proportion to the judgment and discretion shown in their application.

"Variety in ornaments should not be carried to an excess. In architecture they are only accessories; and therefore they should not be too striking, nor capable of long detaining the attention from the main object. Those of the moldings in particular, should be simple, uniform, and never composed of more than two different representations upon each molding; which ought to be cut equally deep; be formed of the same number of parts; all nearly of the same dimensions, in order to produce one even uninterrupted hue throughout; so that the eye may not be more strongly attracted by any part in particular, than by the whole composition . . . .

"When friezes or other larger members, are to be enriched, the ornaments may be significant, and serve to indicate the destination, or use of the building; the rank, qualities, profession, and achievements of the owner. In sacred places, all obscene, grotesque and heathenish representations ought to be avoided; for indecent fables, extravagant conceits, or instruments and symbols of pagan worship, are very improper ornaments in structures consecrated to Christian devotion. . . . .

"In architecture, the most exquisite ornaments lose all their value, if they load, alter, or confuse the form they are designed to enrich and adorn. . . . .

"In the application of their ornaments, they observed to use such as required a considerable relief, on mouldings, that in themselves are clumsy, as the ovolo and astragal; which, by means of the deep incisions made in them to form these enrichments, acquired an extraordinary lightness; but on more elegant parts, as the cavetto and cima, they employed thin bodies, which could be represented without entering too far into the solid. . . . .

"When objects are near, and liable to close inspection, every part of the ornament should be expressed, and well finished; but when they are much exalted, the detail may be slightly touched, or entirely neglected; for it is sufficient if the general form be distinct, and the principal masses strongly marked. A few rough strokes from the hand of a skillful master, are much more effectual than the most elaborate finishings of an artless imitator; which, seldom consisting in more than smoothing and neatly rounding off the parts, are calculated to destroy, rather than to produce effect."

Of these paragraphs there are two to which we desire to call particular attention, although there is not a word which is not absolutely true and no precept laid down which can be disregarded without violating the principles of sound architecture.

The first of the paragraphs of which we desire especially to speak runs "When friezes or other large members are to be enriched, the ornaments may be significant and serve to indicate the destination or use of the building." This precept is one which is very generally disregarded, and for no other reason it would seem than because a lazy habit of mind inclines us to repeat familiar forms whether they are appropriate or not. An excellent example of the correct use of ornaments of this character is in the Guaranty Trust Company, essentially a banking building, where the decorative ornaments are copies of coins; these indicate "the destination or use of the building." On the other hand we very commonly see friezes ornamented with bulls' skulls, which are used indifferently in modern practice over the doorways of banks, residences and schools. The ornament was originally, just as Benjamin says, to indicate the "destination of the building"; it was an ornament designed to express the sacrificial uses of certain temples, but in modern practice the only building whose destination its use could indicate would be a veterinary college. While the Romans made from the bull's head an interesting, and even a beautiful decoration the subject in itself did not seem particularly adaptable to decorative purposes, and its use to begin with was probably forced. Now, with the old world full of natural forms, we should be able to find among them some which could be used as a basis of design to indicate the purpose of any building without resorting to an ornament of dubious artistic value and of no significance.

The second especially illuminating phrase which Benjamin has used, reads as follows: "In architecture the most exquisite ornaments lose all their value if they load, alter or confuse the form they are designed to enrich and adorn."

This principle is of late beginning to be put in practice by the best of our designers. We have come to realize that a wall panel should not have ornament raised in tremendous relief, but the essential flatness of the surface should be preserved; we are no longer decorating molding after molding with a variety of intricate ornamentation, which alters and confuses the forms until they become uninteresting, and we are coming at last to have a respect for simple members and run moldings as reverent and serious as was the respect of a generation ago for the building which had no part of its entire surface left untouched by the chisel of the stone carver.

THE question of the entrance of women in various professions and arts is no longer an academic one; it is an established fact, and at the present time, when the whole subject of the economic position of women is being so much agitated and is so important, it may be worth while to discuss briefly what American women have so far accomplished in the arts and the prospects of future accomplishments by them.

Probably the first field of endeavor which they actively entered and the one in which they have been most completely successful, has been that of letter. It is unnecessary to enumerate the women who have distinguished themselves as poets, novelists and biographers during the past hundred years or more and their activity far from being on the wane, is so constantly on the increase, that here in the United States, magazine fiction and magazine poetry are almost monopolized by women, and the statement was even boldly made the other day in a gathering of rather well known people, that the three greatest living American novelists are women, the names given being: Edith Wharton, Anne Douglas Sedgewick and Margaret Deland.

This assertion was instantly disputed by the men present; but, on reflection, they found it hard to name three American men novelists of equal ability and repute, although they all agreed that no American women occupy quite as high a place in literature as some of the Englishmen—Kipling, Barrie, De Morgan, Hewlett and others.

Of women painters and illustrators, there are quite a number in the first rank—Cecilia Beaux and Mrs. Blumenshein among the painters and Florence Scovell Shinn and Rose O'Neill among the illustrators being women not only of technical excellence, but also of distinct individuality. Among the sculptors, while there are few women who have executed work of a monumental character, the work of Janet Scudder and Bessie Vonnoh is invariably well placed in American exhibitions, and there are many other women of nearly equal ability, comparing favorably with the best of the men who work in the same vein.

Of women composers of distinction, there seems to be none; but on the other hand, there are few American composers of quality, and while there may be no women who are able to stand beside MacDowell and Nevin, we fail to recall any other men of recognized merit in this art.

Like music, architecture has failed to develop women practitioners of recognized superiority, and although there are several women in the profession whose work is of a very respectable order, those whose names come to mind as having built residences or informal buildings of good quality, none of them seems to regard the profession in quite the same way as the men who compete with them. Architecture is with them rather an avocation than a vocation, and although we cannot say that there are no men who do not regard their profession in a somewhat similar way, they are hardly regarded seriously.

Yet, of all the arts, it would seem that architecture, with its dependents, landscape architecture and interior decoration, would be the one most attractive to women, and the one in which they are best fitted to work, as well as the fact that there are so few women practitioners of architecture, for there never was a woman client since the world began who did not believe that she had a heaven sent gift for the profession. Certain aspects of the profession would seem to be peculiarly attractive to women, both because of the opportunity it gives them to exercise taste and artistic perception, as well as because all residence work is designed to meet women's requirements.

Among the few women who have entered the profession, there is none who has achieved distinction of the first rank. It is of course true that there are thousands of men of fair rating as compared with dozens of women, and even a good part of these women have necessarily subordinated their art more or less to their home life, so that it is not so surprising to find few women of recognized talent as it is to find any at all.

There was a young woman sculptor some years since who was looked upon as being one of the most promising of the younger generation of America's sculptors, and who was even intrusted with the execution of a very prominent piece of statuary at the Chicago Exposition. She married, and while her husband is today a distinguished sculptor, of her work we hear nothing, although potentially she may be his superior.

The old theory of art to the contrary notwithstanding, artists are made as well as born, and constant application, training and practice are as necessary to perfect an art as the inborn instinct. The instinct seems to be not uncommon in women; the application, training and practice are infrequent, not for the reason that the suffragist advances, that for thousands of years women have been kept in a subordinate place by men, and have not been trained, educated and permitted to develop independent careers, for this argument is as absurd as it is common, and the very women who use it are the daughters of hundreds of generations of well trained men, just as the men with whom they compete are the sons of as many generations of untrained women. There is nothing in hereditary training which does not affect the women as well as the man, but there is an hereditary point of view of women and their activities which unquestionably militates against their success. We have gradually become willing to intrust women with the execution of small commissions—those which we perhaps with unconscious contempt regard as being within their "sphere"—and while Janet Scudder and Bessie Vonnoh are commissioned to do garden fountains and delicate statuettes, they are not even considered for monumental groups nor for memorial portrait statues, which two classes of sculpture are the ones on which lasting reputations are based.

Women architects perhaps have little opportunity. The same clients who would not hesitate to employ Theodate Pope for a residence or a school building, would probably not even consider her as a competitor for a State Capitol or a big banking institution, and this attitude toward women practitioners of architecture as well as of the other arts, is one which can be overcome only very slowly and by

continuous demonstration of the recognized ability of the woman.

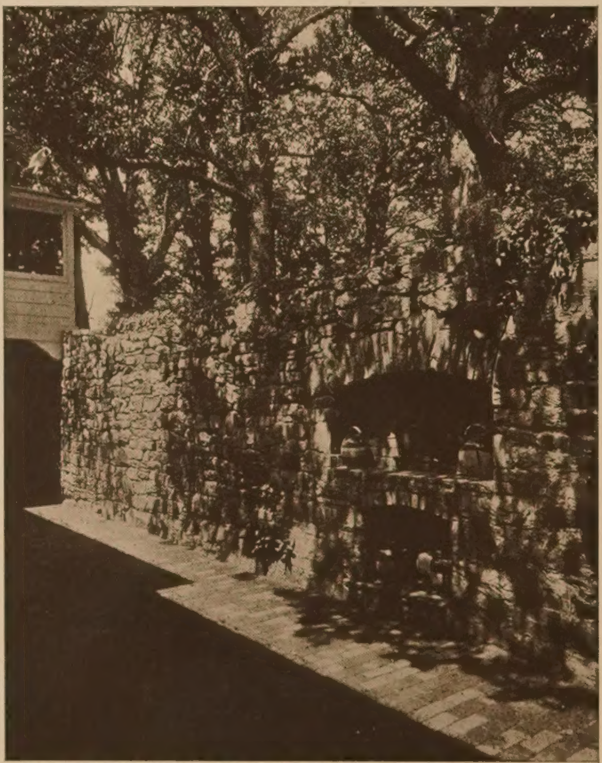
Nor can we feel that this lack of confidence is entirely unjustified. The type of mind that goes with the physical makeup of a woman is different (not inferior) from that of a man, and while there are exceptional women who bring to their work the same initiative that the average man brings, the average woman is deficient in this important respect. That this is actually the case is demonstrated daily in our Art Schools, where fully half the pupils are women, but ninety-nine per cent. of the successes are men, although women may, as pupils, exhibit apparent ability far above the men who, thrown upon their own resources, surpass them. Women are too content to learn—are curiously humble about their own abilities. Every male painter or architect,—no matter how unrecognzied he may be—is immensely satisfied with his own ability and it is this very quality of vanity which is most important to his success since he dares attempt anything which comes his way, and occasionally displays a talent which surprises his contemporaries far more than it does himself.

There is something restless, explorative, about men which tends toward their success, for success in art results as much from originality as from taste and ability. Women, for the most part, are too willing to follow tradition, and to walk in some one's else foot steps. It is only those women whose minds are not of the usual feminine type who can achieve real success, yet no one knows how many women of great ability there are who never had the least opportunity to display it. Had the late Charles Follen McKim been born in the Samoan Islands, we can readily imagine that he might have constructed a durable and tasteful nipa hut for himself, but he certainly never would have built the Pennsylvania Station, and the average woman who marries at twenty-two or twenty-three, moves to the suburbs and rears a family, is about as completely removed from the practice of architecture, as a naked savage on the Pacific Islands.

What the present feminist movement may bring forth in its effect on family life it is impossible to predict, but we can be sure that whatever form it takes it will be to loosen the bounds of women's activities and give more of them opportunity for personal development and with this opportunity there will inevitably come about keener competition in the arts.

THE COUNTRY WORK OF PEABODY, WILSON & BROWN

PAGES 216-245



OLD WALL AND OVEN, HOUSE, GEO. W. BACON, ST. JAMES, L. I.

WE take pleasure in presenting photographs and plans of some of the country work recently executed by Julian L. Peabody, Archibald M. Brown and Albert Wilson, known under the firm name of Peabody, Wilson & Brown.

All the work shown is on the north shore of Long Island, and we feel that those of our readers who are familiar with the old Long Island farm-house type will appreciate what a successful effort has been made to reflect the spirit of the simple architecture of our forefathers, hampered, as architects are today, by the complication of modern requirements. In the Bacon House at St. James and the Brown House at Stony Brook, the natural setting in the trees overlooking the water, and the existence of old houses from which to take the "parti" simplified the task of obtaining an attractive ensemble. At Pond Hollow Farm a new house was built on the site of an old farm house, the two larch trees having formed the sentinels for the original front door.

Messrs. Peabody, Wilson & Brown realize what some of their confreres have not the courage to acknowledge, that the setting of a country house is of prime importance, while the exterior architectural design is purely secondary. They have therefore tried to keep the lines as simple as possible and to use the white shingle walls as a background for the vines and planting. This is especially true of the Westbury house, where the view from the garden—laid out only last winter—already gives the impression of an old fashioned flower garden. Again, in the dining room of the Brown house, the windows in the three arches are made to slide out of sight into a pocket below the floor, to give full play to the view of the rose garden with its box bushes and the water beyond.

Of the brick buildings shown all are of a public or semi-public character. The Town Hall at Huntington—won in competition and built and furnished for less than $20,000—is already one of the most admired smaller public buildings on Long Island. The two buildings belonging to the Carnegie Institution for Biological Research were designed to conform to existing structures. The vines planted on the stucco walls will soon soften the contrast between the red brick and stucco.

It is to be regretted that we cannot publish in this issue photographs of some of their city work.

ITALIAN STUDIO-DWELLING, ST. MARTINS, CHESTNUT HILL, PHILADELPHIA

DUHRING, OKIE & ZIEGLER, ARCHITECTS

MURAL PAINTING OVER MAIN ENTRANCE, STUDIO, WILLIAM WILLET.

IN our modern life with all its "isms" and affectations we use the word INSPIRATION with a recklessness and ignorance truly amazing. One has but to see the studio-dwelling of Mr. and Mrs. William Willet (plates CXIX-CXXIV) with its surroundings to fully comprehend the immense value of such sources when approached in all seriousness, with heart and brain atuned to the visible forms of organic life and full sympathy therefor.

This little garden spot in St. Martins was laid out and built by Dr. and Mrs. George Woodward, well known lovers of art and patrons of hard working artists; and in providing such a delightful place for an artist to live and work in they have voiced their sentiments in no uncertain tones. The original four walls were used in former generations as a storage place for ice, and the magnificent willow standing guard then grew by the side of a pond—the joy of the youthful skaters of Wissahickon Heights.

Mr. and Mrs. Willet are intense mediaevalists and the atmosphere of the art of early Italy and France pervades all their work both in glass and murals, therefore what more fitting than this environment, for the architects, Duhring, Okie & Ziegler have given them the life and spirit of Lombardy and Ravenna, yet preserving intact the naive quality of repose, sweetness and good feeling towards the neighborhood in which they live. The frontage, terrace, quaint outside stairway, garden and outer court with its pool of running water and wall fountain all read like a page of early Italian history.

Within the house there is a decided home atmosphere—restful furnishings (much of it designed by the artists who live here)—good books, interesting pictures and articles of interest selected with a constant eye for their beauty and utility. Many details are drawn from the mediaeval houses still standing in the Tyrol; various window openings were especially prepared to hold fragments of stained glass which Mr. and Mrs. Willet made to serve them as studies for the immense windows which they built for the West Point Chapel, Calvary Church and St. Paul's Cathedral, Pittsburgh, Proctor Hall, Princeton Graduate School and the new chapel in Greenwood Cemetery, New York. The worm eaten beams that served for rafters in the old ice-house were cleverly utilized by the architects, serving as ceiling beams, door and newel posts; and so throughout the building both interior and exterior there is an air of rough simplicity and magnificent proportion.

The larger part of the building is given over to the studios. Mr. and Mrs. Willet have their own private atelier, and a spacious balcony encircles the main studio where their assistants have ample room and light. The extreme end of the building is entirely of glass providing an unusual aperture in which to study windows in the course of preparation. In short, the whole working end of the building is carefully designed to meet the demands of the artist and craftsman, that in the midst of the natural beauties of that Wissahickon that Arnold Bennett calls a synonym for all landscapes whose beauties cannot be described, the artists may absorb her every mood to be given forth in productions of rare artistic beauty and worth.

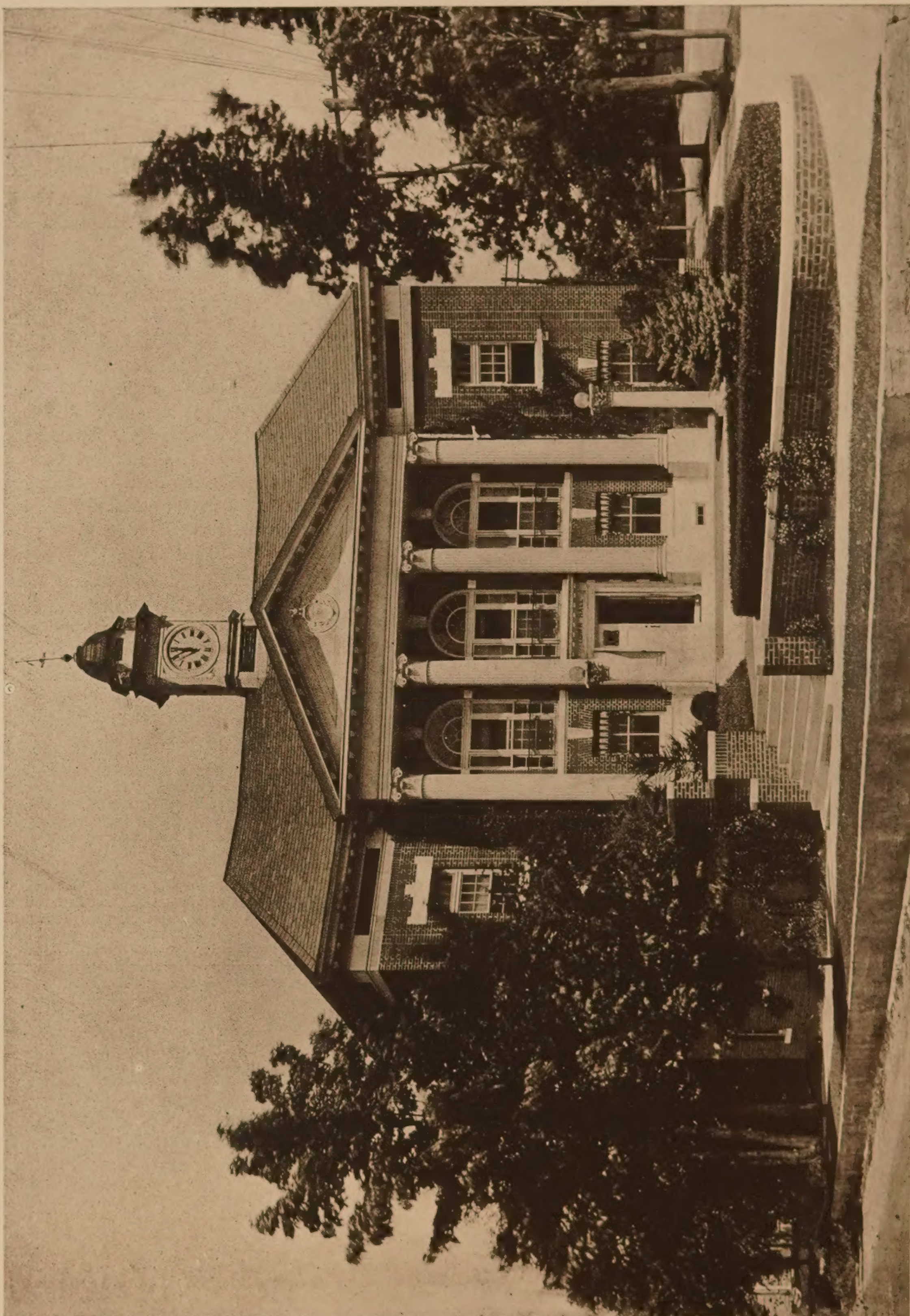
BOOK REVIEW.

VITRUVIUS, THE TEN BOOKS ON ARCHITECTURE.—Translated by Morris Hicky Morgan, Ph.D., Harvard University Press, Cambridge.

Vitruvius was not a great literary personage, ambitious as he was to appear in that character. As Professor Morgan has aptly said, "he has all the marks of one unused to composition, to whom writing is a painful task." In his hand the measuring-rod was a far mightier implement than the pen. His turgid and pompous rhetoric displays itself in the introductions to the different books, where his exaggerated effort to introduce some semblance of style into his commonplace lectures on the noble principles which should govern the conduct of the architect, or into the prosaic lists of architects and writers on architecture, is everywhere apparent. Even in the more technical portions of his work, a like conscious effort may be detected, and, at the same time, a lack of confidence in his ability to express himself in unmistakable language. He avoids periodic sentences, uses only the simpler subjunctive constructions, repeats the antecedent in relative clauses, and, not infrequently, adopts a formal language closely akin to that of specifications and contracts, the style with which he was, naturally, most familiar. He ends each book with a brief summary, almost a formula, somewhat like a sigh of relief, in which he unconsciously shares. At times his meaning is ambiguous, not because of grammatical faults, which are comparatively few and unimportant, but because, when he does attempt a periodic sentence, he becomes involved, and finds it difficult to extricate himself.

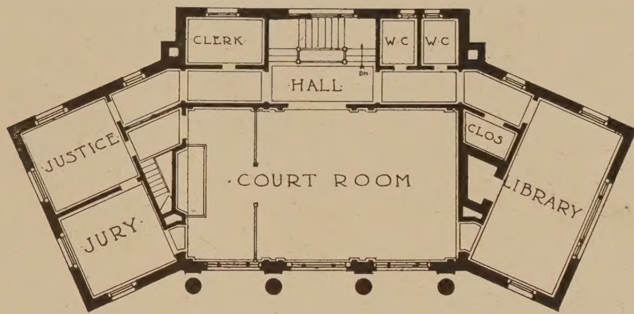
Some of these peculiarities and crudities of expression Professor Morgan purposely imitated, because of his conviction that a translation should not merely reproduce the substance of a book, but should also give as clear a picture as possible of the original, of its author, and of the working of his mind.

The translation is intended to be faithful and exact, but it deliberately avoids any attempt to treat the language of Vitruvius as though it were Ciceronian, or to give a false impression of conspicuous literary merit in a work which is destitute of that quality. The translator had, however, the utmost confidence in the sincerity of Vitruvius and in the serious purpose of his treatise on architecture.

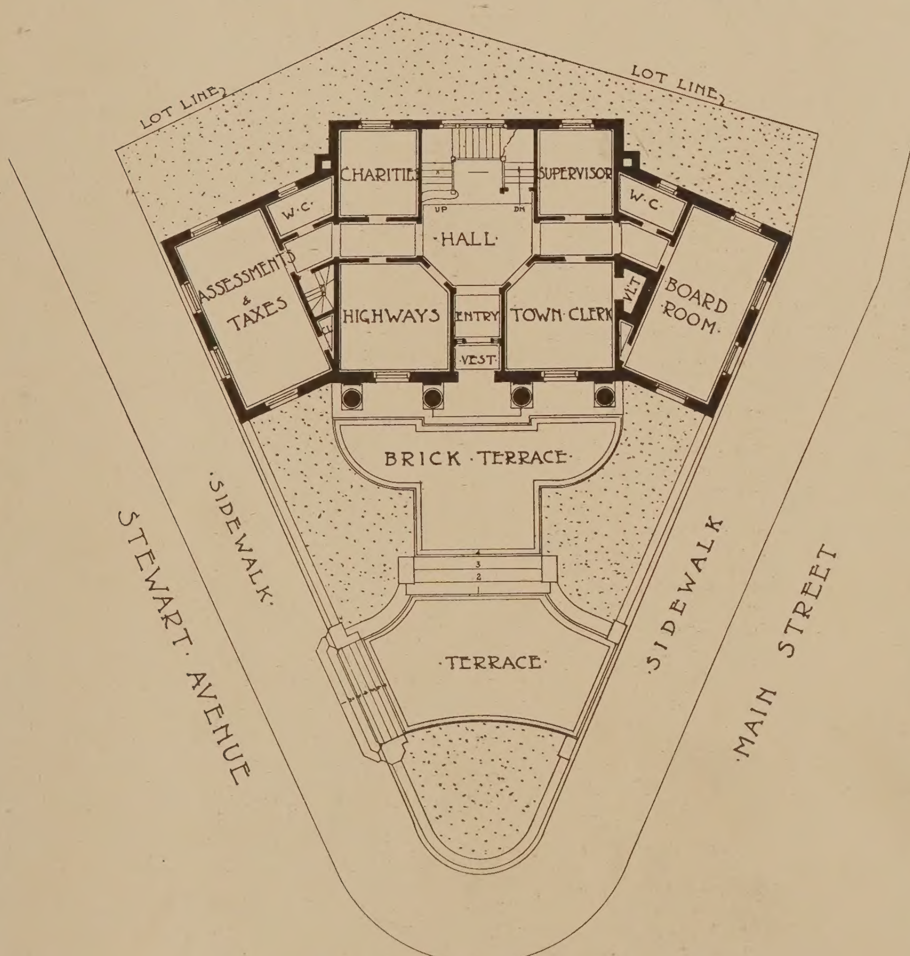


TOWN HALL, HUNTINGTON, L. I.

Peabody, Wilson & Brown, Architects.



·SECOND· FLOOR· PLAN
SCALE·⅛"-1'-0"



·GROUND·FLOOR PLAN·
SCALE ⅛"=1'-0"

TOWN HALL AT HUNTINGTON L·I·

PEABODY, WILSON & BROWN, ARCHITECTS
389 FIFTH AVENUE,
NEW·YORK CITY·

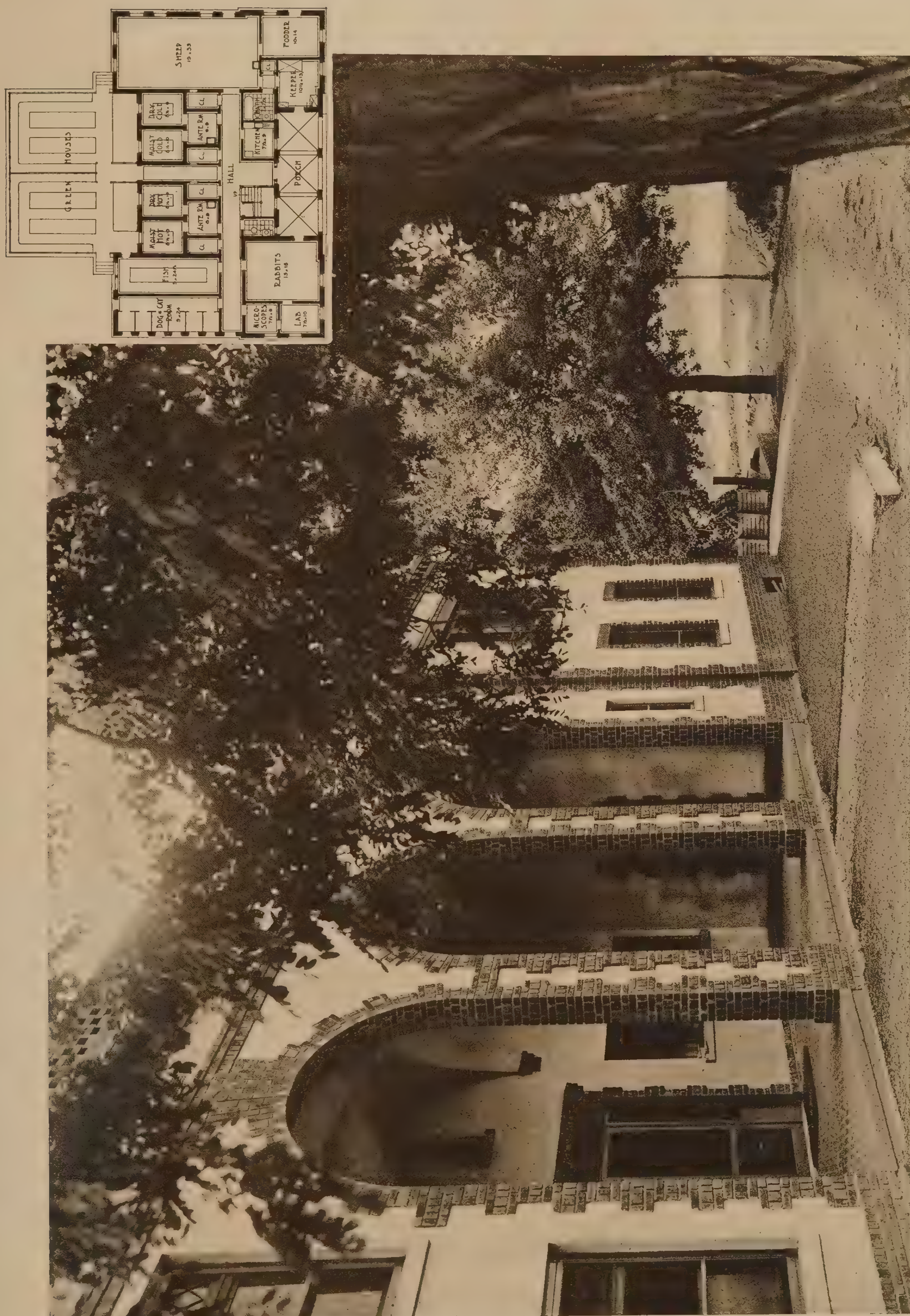
DETAIL, TOWN HALL, HUNTINGTON, L. I.

Peabody, Wilson & Brown, Architects.

LIBRARY, COLD SPRING HARBOR, L. I.

Peabody, Wilson & Brown, Architects.

DETAIL, LIBRARY, COLD SPRING HARBOR, L. I. Peabody, Wilson & Brown, Architects.



EXPERIMENTAL RESEARCH BUILDING, CARNEGIE INSTITUTE, COLD SPRING HARBOR, L. I.

Peabody, Wilson & Brown, Architects.

EUGENICS RECORD OFFICE, CARNEGIE INSTITUTE, COLD SPRING HARBOR, L. I.

Peabody, Wilson & Brown, Architects.

ENTRANCE FRONT, HOUSE, POND HOLLOW FARM, WESTBURY, L. I.

Peabody, Wilson & Brown, Architects.

LAWN FRONT, HOUSE, POND HOLLOW FARM, WESTBURY, L. I.

Peabody, Wilson & Brown, Architects.

Peabody, Wilson & Brown, Architects.

GARDEN FRONT, HOUSE, POND HOLLOW FARM, WESTBURY, L. I.

Entrance, Garden Wall.

Garden.

HOUSE, POND HOLLOW FARM, WESTBURY, L. I

Peabody, Wilson & Brown, Architects

LIVING ROOM, HOUSE, POND HOLLOW FARM, WESTBURY, L. I.

Peabody, Wilson & Brown, Architects.

Dining Room.

Plans

HOUSE, POND HOLLOW FARM, WESTBURY, L. I. — Peabody, Wilson & Brown, Architects.

Garden Porch.

Plan of Grounds.

HOUSE, POND HOLLOW FARM, WESTBURY, L. I. Peabody, Wilson & Brown, Architects.

GUEST COTTAGE, W. D. THORNTON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

FARMER'S COTTAGE, W. D. THORNTON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

HOUSE, GEO. W. BACON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

DETAIL, HOUSE, GEO. W BACON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

Living Room.

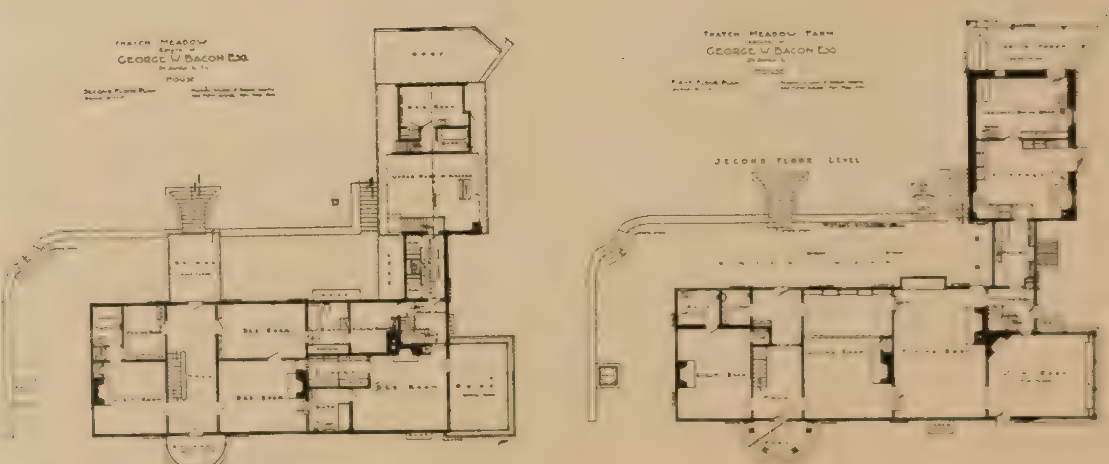
Dining Room.

HOUSE, GEO. W. BACON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

SUN PORCH, HOUSE, GEO. W. BACON, ST. JAMES, L. I. Peabody, Wilson & Brown, Architects.

Hall.



Plans

HOUSE, GEO. W. BACON, ST. JAMES, L. I. Peabody, Wilson & Brown, Architects.

Kitchen Wing.

Farm Buildings.

HOUSE, GEO. W. BACON, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

HOUSE, A. M. BROWN, STONY BROOK, L. I.

Peabody, Wilson & Brown, Architects.

Peabody, Wilson & Brown, Architects.

ENTRANCE FRONT, HOUSE, A. M. BROWN, STONY BROOK, L. I.

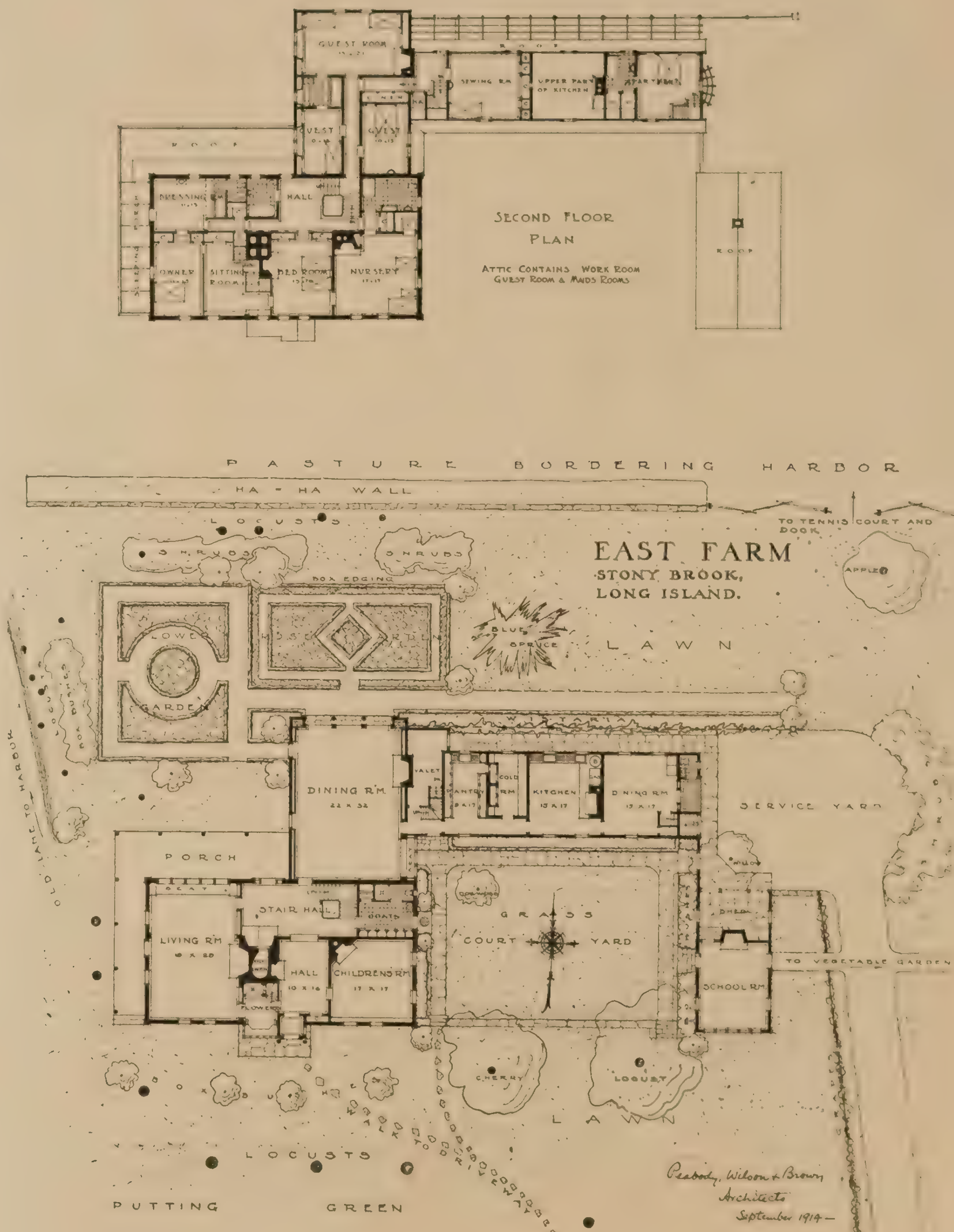
DETAIL, HOUSE, E. M. BROWN, STONY BROOK, L. I. Peabody, Wilson & Brown, Architects.

Living Room.

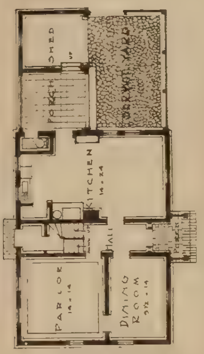
Dining Room.

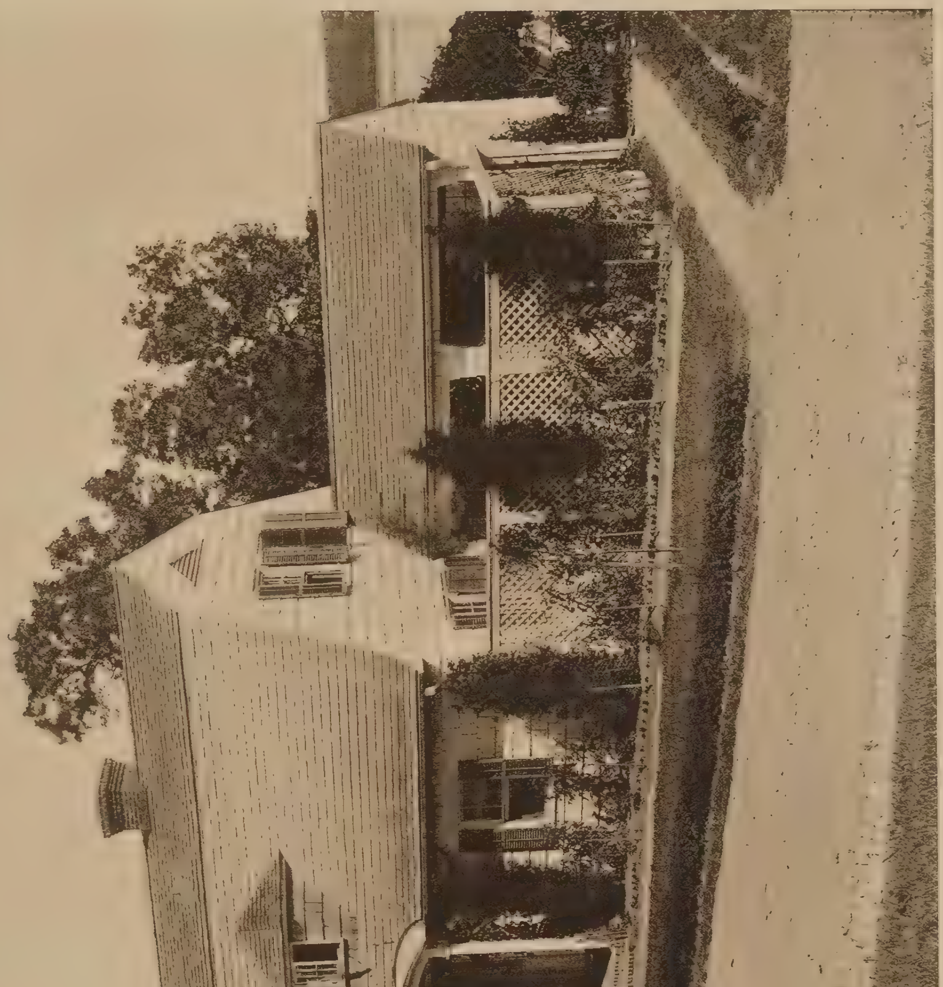
HOUSE, A. M. BROWN, STONY BROOK, L. I.

Peabody, Wilson & Brown, Architects.



PLANS, HOUSE AND GROUNDS, A. M. BROWN, STONY BROOK, L. I. Peabody, Wilson & Brown, Architects.



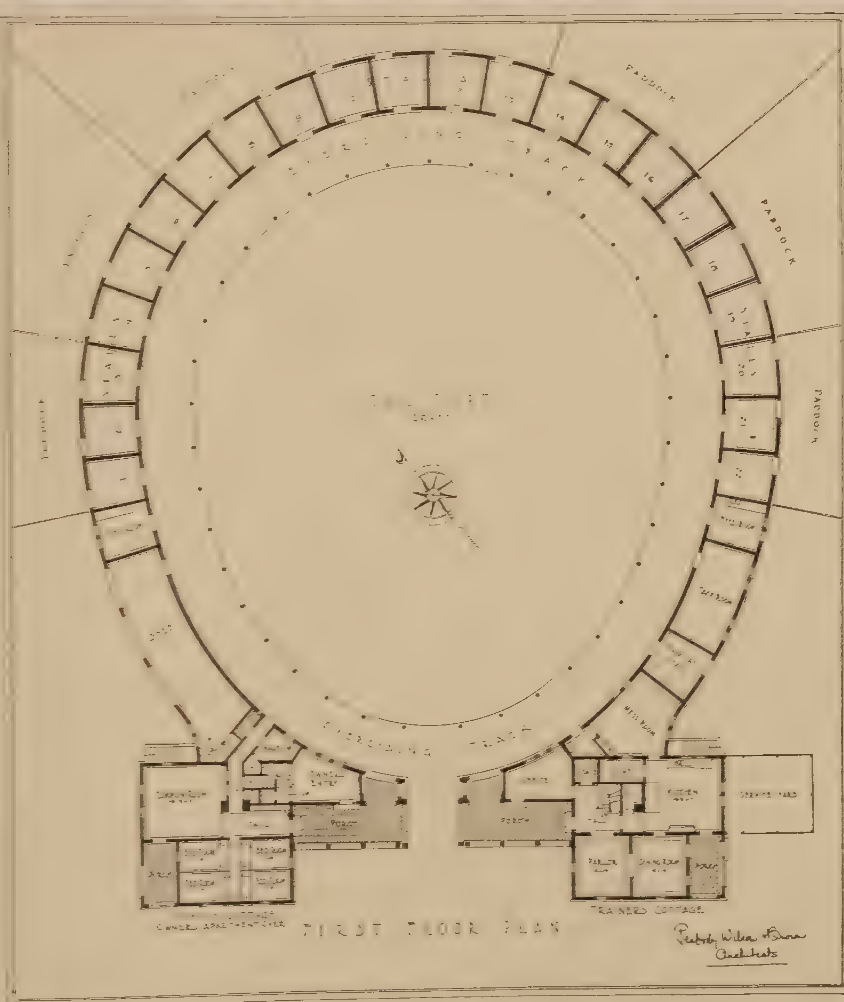


Peabody, Wilson & Brown, Architects.

GARDENER'S COTTAGE, LATHROP BROWN, ST. JAMES, L. I.

RACING STABLE INCLUDING TRAINERS AND JOCKEYS HOUSES, LATHROP BROWN, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.



STABLE COURT AND PLANS, RACING STABLE, LATHROP BROWN, ST. JAMES, L. I.

Peabody, Wilson & Brown, Architects.

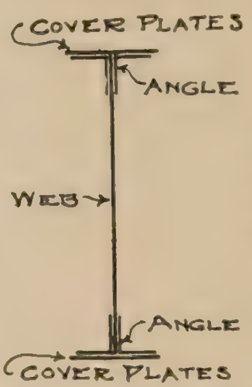
IV. ENGINEERING FOR ARCHITECTS

BY DEWITT CLINTON POND

Mr. Pond has charge of the practical course in structural design at Columbia University. He is extremely successful in instructing men who have had little knowledge of mathematics, and these articles have been written with that in view.

THE standard beams, rolled by the Steel Companies, are strong enough to be used under ordinary conditions, but when the spans are very great and the loads unusually heavy, these beams cannot be made use of. Special girder beams are now being rolled which withstand much more loading than the ordinary I-beam, but there are many conditions which make it necessary to use riveted girders.

Riveted, or "built up" girders, are made of plates and angles, fabricated in such a manner as to give a section very similar to that of an I-beam. The diagram, shown in Fig. 22, shows the parts of a single web-girder. The flange is made of cover plates and angles and the web is made of a single rolled plate usually from three-eighths of an inch to one inch thick. Girders are made with two and sometimes three webs, but as these are difficult to fabricate, the single web girder should be used wherever possible.



FIGVRE 22

There are no two engineers who use exactly the same method in designing riveted girders, but the results given by the method employed in the following problems have always been satisfactory and can be used safely.

Given a girder with a clear span of 36 feet, a uniformly distributed load of 80 tons, and one concentrated load of 60 tons and another of 50 tons, respectively located 12 feet and 26 feet from the left support; the first step is the same as in the case of a simple beam, namely, to determine the reactions. The method is the same as used in Article III.

60 tons x 12 feet	=	720 foot tons.
80 tons x 18 feet	=	1440 foot tons.
50 tons 26 feet		1300 foot tons.
190 tons		3460 foot tons.

3460 foot tons ÷ 36 feet = 96 tons = R_2.

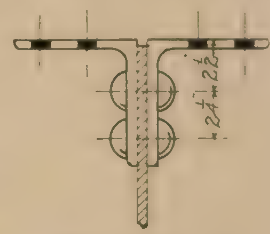
190 tons — 96 tons = 94 tons = R_1.

The maximum shear is equal to the maximum reaction and is therefore 96 tons.

The depth of the girder is considered next. Usually the text-books give the assumed depth of built-up girders as a certain ratio of the span. This ratio is usually assumed as one-ninth or one-tenth.

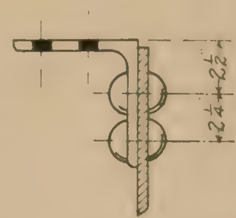
For a girder, 36 feet long, the depth would be about 3 feet 6 inches, or, 42 inches. This depth is the distance between the backs of the flange angles.

The difficulty arising from the use of the above ratio is that no account is taken of the loading on the girder. A formula, based on pure assumptions, but which gives satisfactory results, is often used. The formula is, $d = V/R$, in which V is the maximum shear and R is the shearing value of the rivets used in fabricating the girder. To use this formula it is necessary to assume the size of the rivets, but as a rule, three-quarter or seven-eighth inch rivets are used in all such work. Providing we assume the smaller diameter, we must find the value of three-quarter inch rivets in *double shear*.



FIGVRE 23

When two angles are riveted to a plate, as shown in Fig. 23, then the rivets are said to be in double shear. When one angle is used (Fig. 23a) then the rivets are in single shear.



FIGVRE 23a

Under the heading of "Shearing Values for Rivets" in hand-books, these values are given for unit shearing stresses from 6,000 pounds per square inch to 10,000 pounds per square inch. In the 1909 edition of the Cambria Steel Company's book, page 316, the shearing value of a three quarter inch rivet, having a unit shearing strength of 10,000 pounds per square inch, is given in double shear as 8,836 pounds, or, roughly, as 4.4 tons.

The vertical shear is 96 tons so, as $d = 2\,V/R$, $d = 2 \times 96/4.4 = 44$ inches.

This "d" is known as the *effective depth,* and is not the same as the one given by the use of the ratio. Fig. 24 shows a section of the girder, and between the rows of rivets in the flange angles, centre lines are drawn. The distance between these centre lines is "d".

To find the location of the centre lines, it is necesssary to find the distances from the back of each angle to the centres of the rivet holes. These distances are usually known as the "gauge." Fig. 23 gives the gauge for a 6 inch leg and the distance from the back of the angle to the centre of the rows of rivets is $2\frac{1}{2}'' + 1\frac{1}{8}'' = 3\frac{5}{8}''$ as shown in Fig. 24. $3\frac{5}{8}'' + 44'' + 3\frac{5}{8}'' = 51\frac{1}{4}''$ or roughly 52 inches which equals the distance from the back to the back of the flange angles. This is taken as the depth of the girder, and the use of the formula always gives a greater depth than that obtained by the ratio.

In construction, the depth is often limited by conditions such as the thickness of floors or the available head room, but where it is possible to use a deep girder, the depth obtained by the above formula gives good results, as the deeper the girder the smaller the flange area. In this case a depth of 4 feet, or 48 inches, will be used.

The next step is the determination of the thickness of the web. This can be found directly from the table giving the shearing value of rivets, as this table also gives the bearing values of riveted plates. The shearing value of a three-quarter inch rivet, in double shear is 8,836 pounds. Following to the right, it is found that a ¼ inch plate has a bearing value of 3,750 pounds, a 9/16 inch plate has a

bearing value 8,438 pounds, and a 5/8 inch plate has a value of 9,375 pounds. Under this last value a black line is

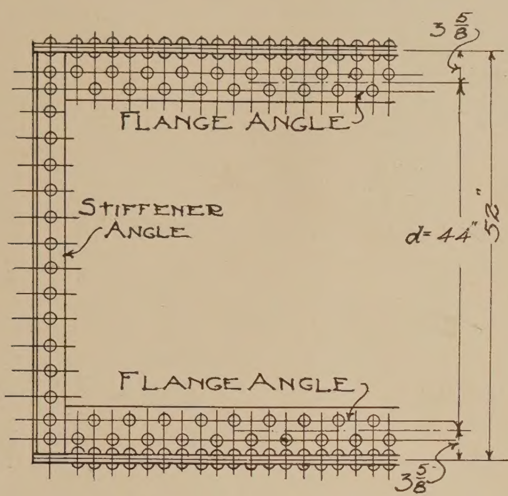


FIGURE 24

drawn, showing that 9,375 pounds is about the same as 8,836 pounds, the shearing value of the rivet. A 9/16 inch plate would give a value a little less than that of the rivet. If the web plate should be 5/8 inch thick, there would be no more tendency for the plate to fail by hearing than for the rivet to fail by shearing.

The above process gives the thickness of the web plate, but this must be checked to determine whether the web will be strong enough to resist the shear. Flanges resist bending and webs resist shearing. The maximum shear is 96 tons. The area of the plate is 52" x 5/8" = 32 square inches. Assuming a shearing value of 4.5 tons per square inch the value of the plate is given by 32 x 4.5 = 144 tons, which is considerably greater than necesssary to withstand the shear.

So far we have determined the depth of the girder and the thickness of the web plate. The next step is the determination of the flange members. The formula used in this case M = SAD, a fairly easy one to remember. M equals the maximum bending moment, S equals the safe tensil or compressive stress of steel, A equals the area of the flange, and D equals the depth. To find A we must first find M. The shear diagram, shown in Fig. 25, gives the point of maximum bending moment as 15.3 feet from R_1. The method employed in drawing this shear diagram was explained in Article III.

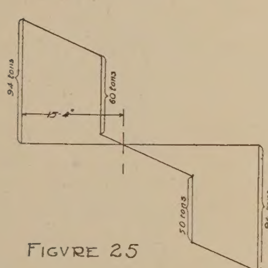


FIGURE 25

To find the maximum bending moment at this point first find the upward moment caused by the reaction. Ninety-four tons x 15.3 feet = 1438.2 foot tons. The downward moments caused by the loading are 2.22 x 15.3 x $\frac{15.3}{2}$=259.84 foot tons, and 60 x 3.3=198 foot tons, or a total downward moment of 457.84 foot tons. The total maximum bending moment at this point then is 1438.2—457.8 = 980 foot tons approximately.

Now, as M=SAD and M equals 980 foot tons, S in the case of riveted steel equals 7.5 tons, and D equals 48 inches, A can be found. $A=\frac{M}{SD}=\frac{980}{4 \times 7.5}=33$ square inches.

This area is made up of two angles and cover plates, and to determine the size of these members some experimenting is required. Good practice requires that all members should have about the same thickness. It would be bad design to have an angle, 1 inch thick, riveted to a plate 3/8 inch thick. As we have already assumed that one leg of each flange angle is 6 inches long we can assume that the length of the other leg is also 6 inches, and the thickness is the same as that of the web plate or 5/8 inch. So the flange angles will be 6 x 6 x 5/8 inch.

Under the heading of "Properties of Standard Angles-Equal Legs" the area of a 6 x 6 x 5/8 inch angle is given as 7.11 square inches. Two angles would have an area of 14.22 square inches. The total area of the flange being 33 square inches, the area left to be made up by the cover plates will be 33 — 14.22 = 18.78 square inches. The width of the cover plates can be taken as 14 inches, and 18.78 square inches divided by 14 inches will give a total thickness of cover plates as 1 3/8 inches. This thickness can be made up of two 1/2 inch plates and one 3/8 inch plate.

The bottom flange is in tension and a portion of the material is lost because of the rivet holes. Fig. 26 shows a portion of the flange and if the plates should fail by tension —pull apart—the failure would occur on either line BB or AA. It is practically certain that failure could not occur on line CC. There would be two rivet holes in the fractured section. For 3/4 inch rivets, holes are punched 7/8 inch in diameter. Each hole pierces a 3/8 inch plate and two 1/2 inch plates as well as an angle 5/8 inch thick. So the area lost by each rivet hole will be (1/2 inch + 1/2 inch + 3/8 inch + 5/8 inch) x 7/8 inch = 1.75 square inches and two holes will cause a loss of 3.5 square inches.

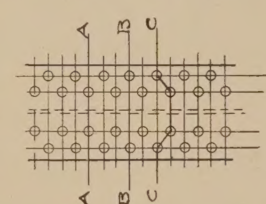


FIGURE 26

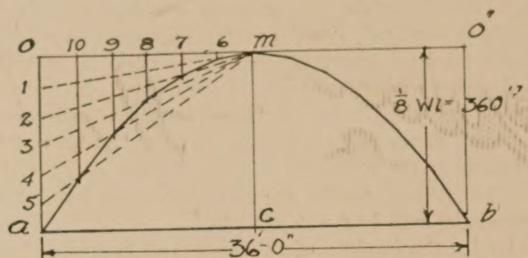
In the case of the upper flange 18.78 square inches had to be made up by plates, and as 3.5 square inches are lost by rivet holes in the bottom flange, 18.78 + 3.5=22.28 square inches must be made up. The total thickness is given by 22.28 ÷ 14 = 1 5/8 inch, and the flange will have one cover plate 5/8 inch thick and two 1/2 inch thick. To facilitate the fabrication of the girder both flanges are made alike and the plates are cut the same length.

To determine the length of the cover plates the bending moment diagram is made use of. Nothing has been said about the method of drawing bending moment diagrams as they are seldom used except in such problems as this. Under the heading of "Bending Moments and Deflections of Beams of Uniform Sections" several types of diagrams are shown in the handbooks. When a beam is uniformly loaded the bending moment diagram takes the form of a parabola.

The method of drawing a parabola is simple, and as it is necessary to know this in order to draw the final diagram for the girder the process is worth mastering. The maximum bending moment for a uniform load is given by the formula M=1/8WE. In case there is a uniform load of 80 tons, on a girder 36 feet long, the maximum bending moment is 1/8 x 80 x 36 =360 foot tons.

In Fig. 27 the line *ab* is laid off to represent 36 feet, for the purposes of demonstration, say at a scale of 1/8-inch

equals 1 foot. This is the base of the parabola and is equal to the length of the girder. The line *cm* is laid off to represent the maximum bending moment. If an inch is



FIGVRE 27

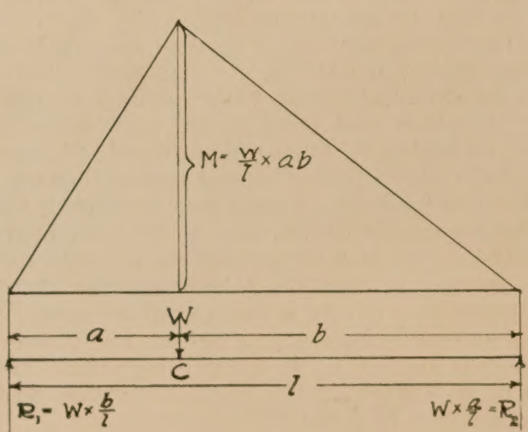
considered as representing 200 foot-tons, 1.8 inches will represent 360 foot-tons. Draw *ao*, oo^1, and o^1b and divide *oa* into six parts. Also divide *om* into an *equal number* of parts in this case six. Starting from *o* on *oa* mark the points 1, 2, 3, 4 and 5 and from *m* on *mo* mark the points 6, 7, 8, 9 and 10. From *m* draw radiating lines to 1, 2, 3, 4 and 5, and from 6 draw a vertical line to *m*1, from 7 to *m*2, and so until from 10 a vertical line intersects *m*5. These points of intersection are points on the parabola and by joining them the bending moment diagram for a uniform load of 80 tons on the girder is completed.

Again referring to the handbook, the bending moment diagram for a single concentrated load is seen to be a triangle, the base being equal to the span and the altitude equal to the maximum bending moment. To determine the value of this maximum bending moment, due to the single concentrated load, the following method is employed.

In Fig. 28, a girder, with a span denoted by "l," is loaded with a single load "W" at a distance "a" from R_1 and "b" from R_2. Then the downward moment around R_1 equals W x a and this equals the upward moment of R_2 x l, or, Wa = R_2l, R_2 then must equal $\frac{Wa}{l}$. In the same manner $R_1 = \frac{Wb}{l}$. The bending moment at c equals R_1 x a or $\frac{Wb}{l}$ x a = $\frac{W}{l}$ x ab. This checks with the moment of R_2 around c, or, $\frac{Wa}{l}$ x b = $\frac{W}{l}$ x ab.

In the case of a girder having a span of 36 feet and a load of 60 tons located 12 feet from R_1, the maximum moment caused by the load will be $\frac{60}{36}$ x 12 x 24 = 480 foot tons, and for a load of 50 tons, 10 feet from R_2 the maximum moment will be $\frac{50}{36}$ x 10 x 26 = 361.1 foot tons.

In Fig. 29 all the diagrams described above are



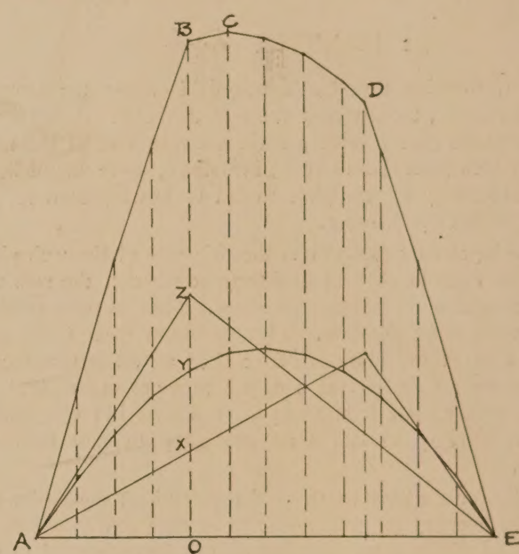
FIGVRE 28

shown. The two triangles represent the bending moments caused by each concentrated load. The parabola represents the bending due to the uniformly distributed load. The line ABCDE represents the *sum* of all the moments due to *all* the loads and is therefore the actual bending moment diagram. The point B is found by the addition of OX, OY, and OZ, or, in other words, OB, = OX + OY + OZ. In the same manner all other points on the diagram are found. It will be found that the maximum bending occurs at C which is 15.3 feet from A.

Now the question naturally arises, what is the use of all this?

Disregarding all the more or less complicated formulas employed to prove that the following processes are correct the next step will be to find the length of the cover plates.

In Fig. 30, the bending moment diagram, already determined, is shown. The area of each flange is made of two angles — 6 inch x 6 inch x ⅝ inch — having an area of 14.22 square inches, one plate—14 inch x ⅝ inch—having an area of 8.75 square inches, and two plates—each

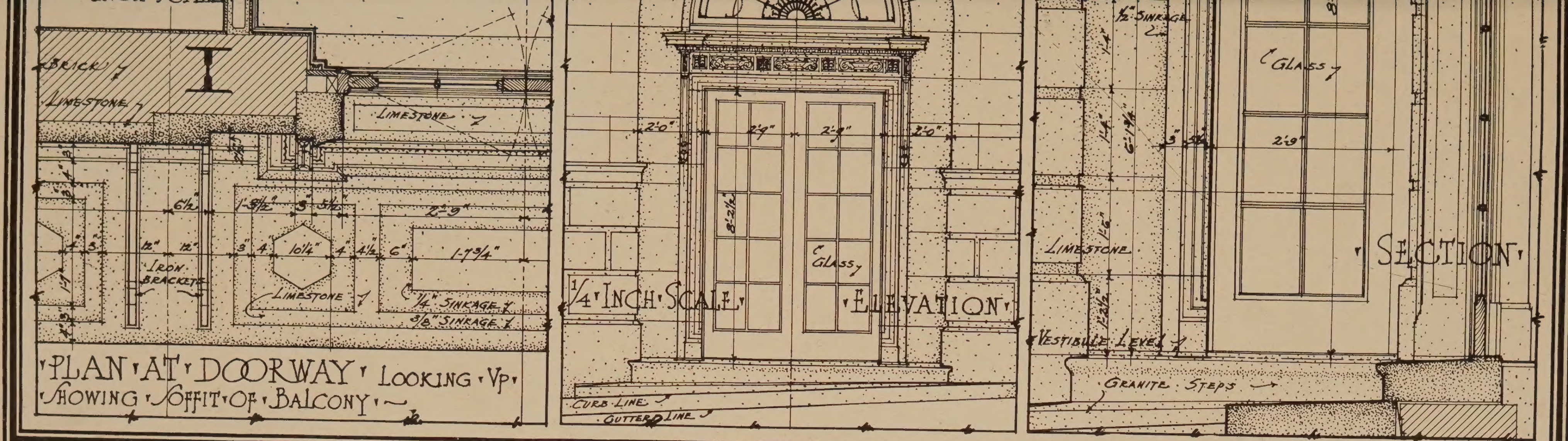


FIGVRE 29

14 inches x ½ inch, having together an area of 14.0 square inches making a total flange area of 36.97 square inches.

Draw through the point e, which is located at the point of maximum bending moment, a horizontal line dd. Between RR and dd lay off a line AB, at some convenient scale, having a length of 36.97 units. On this line lay off AX, having a length of 14.22—the area of the angles,—XY having a length of 8.75—the area of the ⅝ inch plate, YZ and ZB each equal to 7.0 units—the area of each ½ inch plate. Through X, Y and Z draw horizontal lines. The line through X pierces the diagram at a and a^1, and the length aa^1, is the theoretical length of the ⅝ inch plate. The length bb^1 is the theoretical length of the first ½ inch plate, and cc^1 is the length of the other ½ inch plate. The angles of course run the full length of the girder. In actual fabrication the ⅝ inch plate is made to cover the total length of the girder. The bottom plate is made 1 foot 6 inches longer on each end than is theoretical-

(*Continued page xxii*)



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